

The local ties at RAEGE stations

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1. RAEGE project



RAEGE is a project between the **Government of Azores** and the **National Geographic Institute of Spain** to set up a Very Long Baseline Interferometry VLBI **observing network** to meet the international requirements needed for the VLBI Global Observing System (VGOS) and to contribute to the Global Geodetic Observing System (GGOS) to allow better understanding of the dynamics of the Earth environment and conditions of global change in order to make decisions of long-range societal benefit.

The project aims at constructing, installing, and operating four Geodetic Core Sites, two in Spain (in Yebes and Gran Canaria) and two in Azores (in Flores and Santa Maria islands). These multitechnique observatories will be equipped with one radio telescope of VGOS specifications, one permanent GNSS station, one gravimeter and other geodetic techniques. Yebes Observatory will also count with an SLR (Satellite Laser Ranging) station.

2. Local Tie

A local tie survey consists in determining directly or indirectly the relative positions in space of two physical points at a given epoch. The local tie vectors, represent the differential components: dX , dY , dZ between instrument reference points expressed in a geocentric frame.

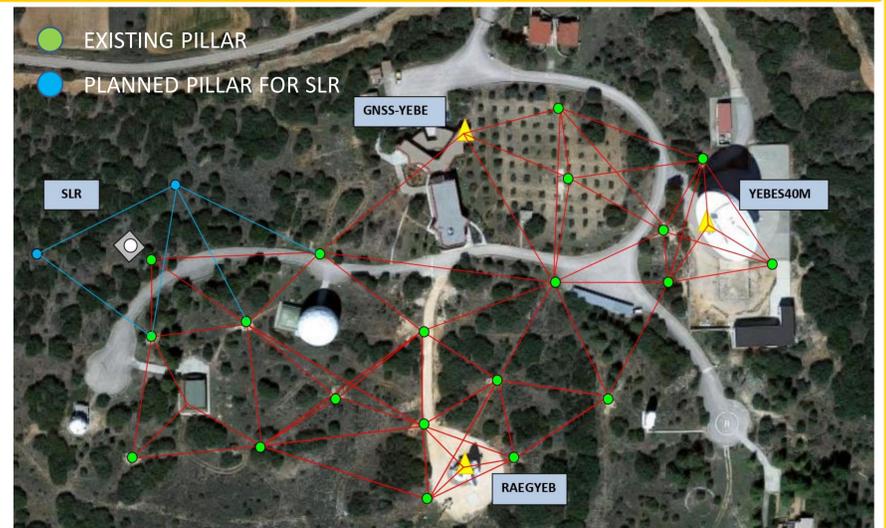


Local tie surveys allows the combination of two or more space-geodetic techniques to better define the realizations of the **International Terrestrial Reference Frame (ITRF)**. They also provide the connection of the invariant reference point (IRP) to the geodetic infrastructure.

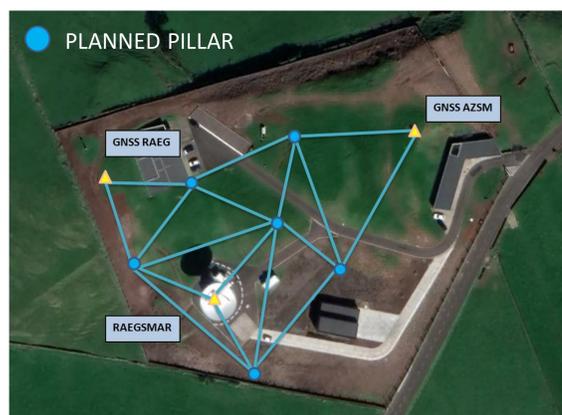
3. Yebes Local Tie

The Observatory of Yebes is a Spanish Unique Scientific and Technical Infrastructure that hosts an important space geodesy infrastructure connected through a local tie whose main features are listed below:

- The network is composed of **20 concrete pillars** aimed at obtaining a balanced polygonation sketch with good intersection of the lines of sights (appropriate distances and angles between the stations and surveyed points). Each pillar has a forced centering screw for precise measurement.
- The network allows to connect 3 GNSS antennas (one of them belonging to the IGS network), 2 VLBI radiotelescopes, a superconducting gravimeter and, in the future, a SLR station.
- The observation of the network is carried out by classical survey methods (levelling + tacheometer) and GNSS observations.
- An indirect approach to obtain the IRP of the VLBI antennas: several targets are stuck on the telescope, and their positions determined from at least one pillar of the local tie network. Then, the telescope rotates in azimuth and elevation and the target positions are determined. Thus, targets draw circles whose centers determine 2 axes and its intersection defines the IRP.
- For the adjustment of the local tie network, *DynAdjust* software package has been used, achieving sub-millimeter results. Then, the estimation of the IRP has been performed by means of the *axis* software (Australia Geoscience).



4. Santa María Local Tie (in the pipeline)



Santa María station was the second RAEGE Core Site deployed. It is placed in Piquinhos, close to São Pedro, in the Santa Maria island (Azores). The Santa María VGOS radio-telescope participates in regular VLBI observations with its tri-band S/X/Ka receiver since end of May 2021. In September 2022, a field survey was performed in order to design the local tie network. The preliminary design is as follows:

- The network will be composed of **6 concrete pillar network**.
- It will allow to connect: 2 GNSS antennas (one of them belonging to the IGS network), a VLBI radiotelescope and a superconducting gravimeter
- It is expected to follow the same approach used in the Yebes local tie: classical survey methods (levelling + tacheometer) combined with GNSS observations for the alignment to the ITRF; and an indirect approach to obtain the IRP of the VLBI radiotelescope.

5. Future plans 2023 - 2024

- Yebes co-location reprocessing according to the guidelines of the IAG/IERS Working Group on Site Survey and Co-location.
- Santa María pillar network construction and observation.
- Deployment of the **new RAEGE Core Site in Temisas** (Gran Canaria).



6. References

[1] (IERS Technical Note ; 39) IGN best practice for surveying instrument reference points at ITRF co-location sites. *Jean-Claude Poyard, with contributions by Xavier Collilieux, Jean-Michael Muller, Bruno Garayt and Jérôme Saunier.*

[2] Realización del local tie de las distintas técnicas geodésicas- espaciales en el observatorio de Yebes. *Beatriz Córdoba Hita, Javier López Ramasco*